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PROBLEMS OF THE STUDIES OF FLUID INCLUSIONS IN TOURMALINES

INTRODUCTION

Tourmalines are common minerals usually of hydrothermal or pneumatolytic origin. The recent study was made on schorlite-dravite from so called tourmaline aplite at Lisiec Hill, forming veins in the metamorphic cover of the Variscan Strzegom granitoid. These tourmalines contain numerous inclusions of various types, showing good examples of the problems occurring in the studies of such objects. Once an interesting idea on the magmatic origin of this tourmaline was published (Puziewicz 1981), however, the fluid inclusion investigations evidenced its metasomatic formation (Kozłowski 1984, 1987, Kozłowski, Metz 1987), confirmed also by the hollow habits of tourmaline crystals filled by and embedded in aplite groundmass (Fig. 1).

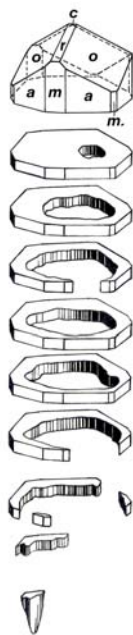


Fig. 1. Hollow tourmaline, height 21 mm.

INCLUSIONS IN TOURMALINE

The primary fluid inclusions were of the gas-liquid type, homogenizing most frequently to liquid phase, rarely to gas phase. They were filled either by aqueous solution and vapour, or by aqueous solution as well as liquid and gaseous carbon dioxide. Their homogenisation temperatures were 340–355°C and CO₂ density in inclusions – 0.5 g/cm³, hence crystallisation temperatures were 410–480°C and pressures 770–810 bar at the total salt concentrations 4.1–5.9 wt. % in aqueous solutions. The recognised problems were as follows.

1. The habit of primary inclusions in tourmaline is usually tubular, and they are oriented parallel to the C-axis. This requires the cutting of preparations of the same orientation, otherwise the inclusions cannot be properly observed and they are frequently open.

2. The heating and cooling procedures must be performed in a stage of minimal thermogradients and on low rate of the temperature changes, to obtain the correct temperature values, because very long (~300 μm) and thin (2–5 μm) inclusions the same time must be whole in the same state, otherwise errors are large.

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3. Tourmalines commonly bear inclusions of aqueous solution, and liquid and gaseous CO_2 , usually of heterogeneous trapping (Fig. 2). However, this should be thoroughly evidenced by the same homogenisation temperatures of pairs of syngenetic inclusions. Volumes of the phases in inclusions should be measured with sufficient precision.

4. Opening of relatively extensive fissures in minerals may cause local boiling of aqueous solution and trapping of the syngenetic liquid-rich and gas-rich inclusions;

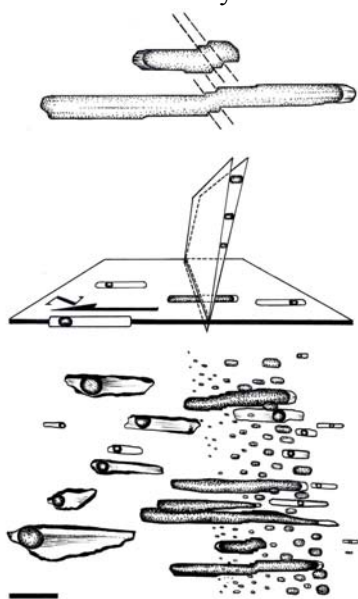


Fig. 3. Refilling of fluid inclusions in tourmaline (*bottom*), scheme of refilling (*middle*), and deformation of the inclusion vacuoles by dense parallel cracks (*top*); scale bar 20 μm .

inclusions may be erroneously considered as crystallized melt inclusions, however, the crystal components of the filling, especially quartz, contain primary inclusions of fluid, indicating their hydrothermal origin. Later fluids, coming through fractures cutting these inclusions, caused alteration of the mineral phases in inclusions or splitting

Fig. 4. Tubular inclusion with two gas bubbles, one formed due to incomplete refilling, f – fissure.

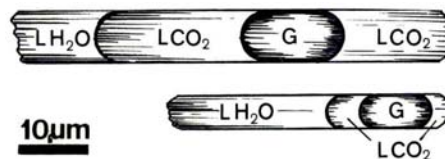


Fig. 2. A pair of inclusions of aqueous solution (LH_2O) and liquid (LCO_2) and gaseous (G) carbon dioxide of heterogeneous trapping.

the deciphered pressure (and possibly deciphered temperature) decrease is also strictly local (in this case to 250–260 bar).

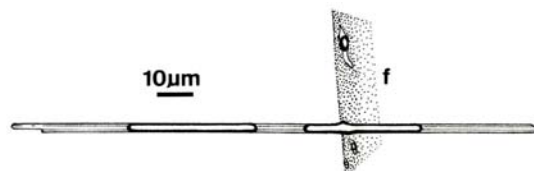
5. Common phenomena of refilling of the inclusions (Fig. 3) make possible the establishing of the sequence of changes of the compositions of fluids, but they may cause a misinterpretation as heterogeneous trapping.

6. Long tubular inclusions opened by a fissure, which was quickly healed, may have two gas bubbles, if the opening occurred after one contraction bubble started to form. The opening might have caused formation of another bubble (Fig. 4).

7. Formation of several small parallel fractures in tourmaline in the area, where a fluid

inclusion occurred, may cause deformation of the inclusion vacuole by shifting parts of tourmaline (Fig. 3).

8. Long acicular inclusions are filled by aggregates of albite and quartz grains, and variable amounts of fluid (Fig. 5). Such



the long inclusion in two ones by crystallisation of tourmaline along the fissure (Fig. 5, albite inclusion).

9. Tourmalines contained secondary aqueous inclusions with droplets of dense organic (hydrocarbon) substance with bluish UV-fluorescence. These inclusions did not yield homogenisation temperatures, but probably they are of low-temperature origin.

10. Tourmalines from the aplites at the Lisiec Hill contain numerous crystal inclusions of several minerals, frequently in perfect euhedral habits (Fig. 5). The identification was made by means of the Cameca sx100 electron probe determinations (in the Inter-Institution Laboratory of Microanalysis of Minerals and Synthetic Substances in Warsaw). The found mineral species comprised spessartine-almandine garnet, albite, quartz, monazite, epidote, rutile, magnetite and andalusite. These crystal inclusions formed essentially during the metasomatic growth of tourmaline, what is evidenced by orientation of the crystal inclusions to the host tourmaline, e.g. for quartz, albite and epidote their *C*-axes were apparently parallel to the same axis of tourmaline. The conclusion was supported by fluid inclusions in the included crystals.

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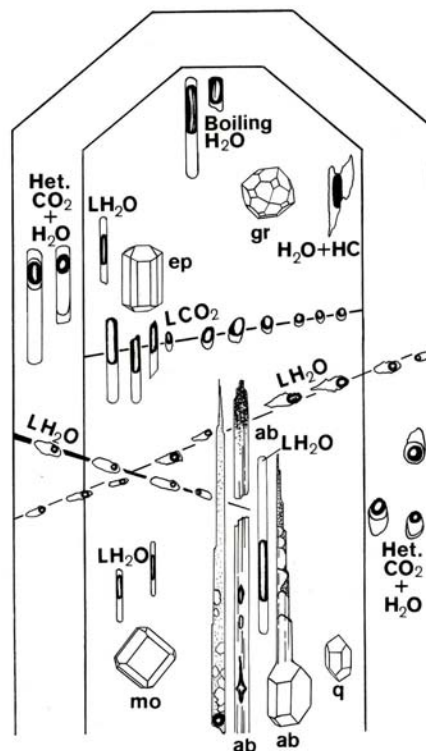


Fig. 5. Scheme of distribution of fluid and crystal inclusions in tourmalines from aplites from Lisiec Hill, environs of Strzegom; *Het.* – heterogeneous, *HC* – hydrocarbons, *gr* – garnet, *ep* – epidote, *mo* – monazite, *ab* – albite, *q* – quartz.

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